



**REPORT**  
**ON THE**  
**ADMINISTRATION**  
**OF THE**  
**METEOROLOGICAL DEPARTMENT**  
**OF THE**  
**GOVERNMENT OF INDIA**  
**IN**  
**1917-18.**



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# REPORT ON THE ADMINISTRATION OF THE METEOROLOGICAL DEPARTMENT OF THE GOVERNMENT OF INDIA IN 1917-18.

## CHANGES IN THE STAFF DURING THE YEAR 1917-18.

The services of Dr. G. C. Simpson were placed at the disposal of the Indian Munitions Board from the 25th April 1917. He is still working there and Mr. W. A. Bion is appointed as sub. *pro tempore* Imperial Meteorologist in his place.

Mr. C. W. B. Normand was appointed to the Indian Army Reserve of Officers from the 29th February 1916, and was sent by the Army Department on the 18th June 1916 to Mesopotamia to work there as Meteorologist. He is still on this duty. Mr. M. G. Subrahmanyam, Head Clerk, Bombay Meteorological Office, has been acting for him from the 1st February 1918.

Mr. W. A. Harwood, who was appointed to the Indian Army Reserve of Officers from the 10th February 1916, is still away on military duty.

Mr. C. W. Peake, Meteorologist, Calcutta, has been on combined leave since the 9th May 1917. Mr. D. B. Meek, Professor at the Presidency College, Calcutta, is acting for him.

Mr. J. Evershed was on privilege leave from the 12th December 1917 to the 11th January 1918.

The services of Dr. T. Royds were placed at the disposal of the Army Department for employment in the Office of the Director of Ordnance Factories, Calcutta, from the 24th October 1917. He is still there and Mr. S. Sitarama Aiyar is appointed as sub. *pro tempore* Assistant Director of the Kodaikanal Observatory in his place.

## OBSERVATORIES.

2. The observatories maintained by the Government of India are classified as follows :—

*First Class.*—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

*Second Class.*—Observatories at which readings are taken daily at 8 hrs., 10 hrs., and 16 hrs.; those at 8 hrs., are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay, and Madras for inclusion in India or Provincial Daily Weather Reports.

*Third Class.*—Observatories—

(a) where readings are taken daily at 8 hrs. only; at those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(b) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

*Fourth Class.*—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only are recorded.

*Fifth Class.*—Observatories which telegraph rainfall only.

3. At the end of the year the total number of observatories was 273, of which 41 were non-departmental and 232 were maintained by the Government of India. Of the 232 departmental observatories 5 were first class, 181 third class, 23 fourth class, and 23 fifth class.

#### 4. The changes in the observatories during the year were the following :—

The observer's work at Pasni was so bad that the third class observatory there had to be closed from the 19th July 1917 to the 11th October 1917 until another man could be appointed. The second class observatories at Kalabagh and Sarain on the Chur Peak were closed from the 1st December 1917. The third class observatory at Baghdad was re-opened on the 4th January 1918.

#### FIRST CLASS OBSERVATORIES.

5. The Directors of the observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

6. *Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta. The following special instruments were in use during the year :—

A Bergholz barograph, a Dines' microbarograph, a Kew thermograph, a Beckley anemograph, a Dines' pressure tube anemometer, Beckley, Hellman-Fuess and monthly rain-gauges, two Omori-Ewing seismographs, grass and ground thermometers, and a nephoscope. The Kew barograph and the Richard thermograph were put out of use from the 2nd August and the 6th November 1917 respectively.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 1,470 as compared with 1,311 last year : 32 instruments were condemned as unfit for issue, or were sent to the India Office for repair and 5 instruments were kept in store for future treatment. In addition to the above, 196 instruments were examined and issued to other observatories.

The observatory gives mean Calcutta time to the port and shipping. Three time-balls are dropped daily at 1 p.m., local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks. This work was carried out quite satisfactorily as far as this department is concerned. There were 31 failures, as compared with 17·3, the average number of the past 29 years ; all these were due to defects in the electric or mechanical arrangements outside the observatory, for which this department is not responsible.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1917-18 .. .. .	31	34
1916-17 .. .. .	56	41
1915-16 .. .. .	17	17
1914-15 .. .. .	24	21
1913-14 .. .. .	36	36
1912-13 .. .. .	50	50

7. *Lahore Observatory.*—The following special instruments were in use during the year :—

A Draper barograph, a Casella rain-gauge, a Beckley anemograph, a sunshine recorder, grass and ground thermometers, and a nephoscope. The Richard barograph was put out of use from the 5th November 1917.

Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years at 6, 8, 10, 14, 16, 18, and 22 hours. Ground surface temperature was recorded four times daily at 6, 8, 10, 16 and 22 hours. Cloud observations were taken daily by nephoscope at 8, 12 and 16 hours for use at the Aerological Observatory, Agra.

## CHARACTER OF THE WORK OF OBSERVATION AT SECOND AND THIRD CLASS OBSERVATORIES.

8. The general character of the work of the observatories, as judged by the number of mistakes made by observers, was satisfactory.

The number of stations of great reliability, in which either no mistake or only one mistake has been detected in the data for the Indian Daily Weather Report, was 33 as against 21 in 1916-17; while the number of stations at which more than 50 mistakes were made was 3 as against 8 last year.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office was prepared and circulated to the observatories on the 7th June 1918.

### INSPECTION OF OBSERVATORIES.

9. The number of visits paid to observatories during the year under review was 44 as compared with 52 in the previous year and an average of 54 during the past 10 years.

The Director-General inspected the observatories at Bombay and Agra. Mr. W. A. Bion inspected 6, Mr. P. K. Ghose 27, Mr. M. G. Subrahmanyam 1, and Mr. Budha Mall 8.

Of the 42 third class observatories that were visited 27 were reported as good, 11 as tolerable and 4 as bad.

Condition.	SECOND OR THIRD CLASS OBSERVATORIES INSPECTED IN —					
	1917-18.	1916-17.	1915-16.	1914-15.	1913-14.	1912-13.
Good or satisfactory .. ..	27	33	21	52	31	31
Tolerable .. ..	11	7	10	14	23	17
Bad .. ..	4	..	..	3	6	3
Total .. ..	42	40	31	69	63	51

In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

### SPECIAL OBSERVATIONS.

10. Observations other than those recorded at regular intervals are made as follows:—

- In accordance with orders issued from the Simla or Calcutta Office, when weather is disturbed and storm warnings may have to be issued; such observations are reported by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Rs. 1 for each set of special observations sent under instructions from either Simla or Calcutta. The total number of telegrams forwarded during the year under review was 1,878 compared with 1,592 during the previous year.
- Certain observers, when they consider that conditions at sea are sufficiently threatening, send of their own initiative to Simla or Calcutta a telegram containing special observations. Six such telegrams were received.
- In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and certain railway engineers who desire early information. The number of telegrams sent was 275 as compared with 220 last year.
- Observers are instructed to send detailed information of earthquakes to the Simla Meteorological Office and to the Director, Geological Survey, Calcutta; for this work they are paid awards from this department. Of such reports 83 were received during this year.

## OBSERVATIONS WITH SPECIAL METEOROLOGICAL INSTRUMENTS.

11. The following special observations were carried out during the past year at certain selected stations:—

- 1st.—Wind observations recorded by Beckley anemographs at 8 stations, and by Dines' pressure tube anemometers at 4 stations.
- 2nd.—Solar and terrestrial radiation observations at 1 and 8 stations, respectively.
- 3rd.—Underground temperature observations at 2 stations.
- 4th.—Sunshine observations at 6 stations.
- 5th.—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 18 stations.
- 6th.—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 9 stations.

## OBSERVATIONS OF SOLAR ENERGY IN ABSOLUTE UNITS.

12. Observations at Simla by means of Angstrom's electric pyrheliometer continued in abeyance owing to shortness of staff.

## UPPER AIR EXAMINATION.

13. Work with pilot balloons was continued throughout 1917-18 at the same stations as previously, Agra, Simla, Kojak, and Bangalore; and it was started at Lahore on the 20th March, 1918. The results were treated as before, and for the series of years now available at each place most of the figures of half monthly and monthly vector resultants have been plotted to show the resultant trajectories of the period. The variations of corresponding periods from year to year are thus recognizable, for association with the variations in weather.

The series of balloons carrying recording instruments was continued at Agra.

Publication of observations and results is deferred in accordance with the general policy of Government in war time.

A year's series of air temperature observations under the normal Indian thatched thermometer shed and with two other methods of exposure, namely under a tiled shed and in a Stevenson screen, was completed. The object was to ascertain what differences in results, if any, would be involved by the adoption of the less inflammable shed for general use in India, and to estimate the divergence of temperature between the standard Stevenson screen exposure of thermometers at fourth class stations in India and that in the standard thatched shed of other Indian stations. Examination of the results shows appreciable divergences, and has raised questions which need further observations to answer. A second year's observations have therefore been started with certain modifications and additions. These include the use of a third shed, tiled and lined with wood, and the use of a motor-ventilated open-air exposure of maximum and minimum thermometers, shielded from external radiation in Assmann jacket tubes. A number of important results are indicated but the examination of these is not yet completed.

## RESEARCHES BY THE SIMLA STAFF.

14. Owing to the absence on war work of Simla gazetted officers the only researches found possible have been statistical examinations of various types. These are shortly stated in section 33 below.

## SEISMOGRAPH OBSERVATIONS.

15. Seismological observations were recorded throughout the year by two Omori-Ewing seismographs at Simla and at Calcutta and one at Bombay; by Milne seismographs at Kodaikanal and Colaba (Bombay); and by means of other self-registering instruments at the last-named station. All the instruments worked satisfactorily throughout the year, and data were transmitted to the Seismological Committee of the British Association.

## MARINE METEOROLOGY.

16. No change was made during the year in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard, for the purpose of applying the necessary corrections to the readings in the logs; and, after the barometer comparisons have been made, a statement of the error of the ship's barometer is given to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangement made with Royal Alfred Observatory at Mauritius, for collecting marine data from the Indian Ocean, has been continued, and the thanks of this department are again due to that office for thus supplying a large amount of useful data. No such data were received from the London Meteorological Office during the year.

#### SNOWFALL REGISTRATION IN THE MOUNTAIN DISTRICTS TO THE NORTH AND WEST OF INDIA.

17. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the department are again due to the various officers who have collected and forwarded it. Unfortunately the series of large-scale photographs of the snows, as seen from Simla, which was started in 1905, has had to be discontinued during the war.

#### RAINFALL REGISTRATION.

18. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director-General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new rain-gauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5-8 of the Administration Report of the year 1889-90, and on pages 6 and 7 of the Administration Report for the year 1890-91.

The following is a statement of the number of rain-gauge stations from which data were received for publication in the Rainfall Data of India at the end of the year :—

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1918.	Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1918
Burma .. .. .	213	Baluchistan .. .. .	90
Assam .. .. .	125	Rajputana .. .. .	186
Bengal .. .. .	230	Bombay and Sind .. .. .	289
Bihar and Orissa .. .. .	300	Central India .. .. .	122
United Provinces .. .. .	275	Central Provinces and Berar .. .. .	189
Punjab .. .. .	190	Hyderabad .. .. .	19
Kashmir .. .. .	39	Mysore .. .. .	77
North-West Frontier Province .. .. .	36	Madras (including Pudukkottai, Coorg, Travancore and Cochin).	525



The following paragraphs give a brief summary of the reports of the officers in charge of rainfall registration for the year 1917-18 :—

*Assam*.—The number of gauges inspected was 56 or 31 less than in the previous year, and the total number of inspections was 82 against 141 the previous year. Nineteen rain-gauges were inspected more than once.

*Baluchistan*.—Only 14 stations were inspected.

*Bihar and Orissa*.—Here out of 300 stations 183 stations were inspected and 219 inspection cards were received against 205 last year. On the whole the rainfall registration work was satisfactory.

*Bengal*.—Of the 230 rain-recording stations in the Province 40 stations were inspected as against 56 in the previous year.

*Bombay and Sind*.—Out of 278 rain-gauges in British districts 206 were inspected, 69 being inspected more than once. The total number of inspections was 391. In Native States, 40 gauges were inspected out of 61 : the total number of inspections was 48.

*Burma*.—Of 212 rain stations 18 were meteorological observatories, 25 were in charge of the Public Works Department, 2 in charge of the Agricultural Department and the rest were under District Officers. Of the rain-gauges, 152 were inspected : 117 were in good order, 29 were in fair condition, and 6 were unsatisfactory.

*Central Provinces*.—There were 175 inspections against 151 the previous year. The results attained during the year show that the work of registration is carried out with efficiency.

*Berar*.—The number of inspections of the 43 rain-gauges was 103 against 161 in the previous year.

*Hyderabad*.—The rainfall registering stations of Hyderabad are in charge of the Nizam's Public Works Department. There are 17 stations, of which 11 were inspected during the year. In addition there is a rain-gauge in charge of the Residency Surgeon and one at Bolaram in charge of the Senior Medical Officer.

*Kashmir*.—There were 38 rain-gauges in this State, of which 8 are meteorological observatories and the remainder are in charge of the Revenue Department.

Fourteen rain-gauges were inspected as against five last year.

*Madras*.—Out of 496 rain-recording stations 395 were in the Madras Presidency, and of these the number inspected was 390.

*Mysore*.—At the close of the calendar year 1917, the number of rain-recording stations was 226 against 224 the previous year : of these 201 were inspected against 213 inspected last year.

*North-West Frontier Province*.—The report on rainfall registration contained in the current administration report of land revenue, land records and agriculture of this province refers to the year 1916-17 and states that there was no change in the situation of the rain-gauges. These and the rainfall registers are generally reported to be in good order and properly maintained.

*Punjab*.—The number of rain-gauges in the Punjab was 213, of which 119, are in charge of district officers and 97 in charge of irrigation officers. There were 43 inspections of the district rain-gauges. Those under irrigation officers were regularly inspected.

*Rajputana and Aimer-Merwara*.—During the triennial period ending the 31st March 1916, there were 414 rain-gauges, of which most were inspected during the period under review. Out of 18 rain-gauges in Kotah 13 were inspected, and none of the 14 gauges in Dholpur were inspected.

*United Provinces*.—Out of 271 stations under district and canal officers, 51 per cent. were inspected as compared with 56 per cent. last year.

*Summary*.—In the Central Provinces, Berar, Madras, and Mysore, the proportion of the rainfall stations inspected was over 75 per cent., which is satisfactory. In Assam, Bihar and Orissa, Burma, Hyderabad and the United Provinces, where between 50 and 75 per cent. of gauges were inspected, the efficiency of the system must suffer before long. But the proportions in the remaining provinces—Bombay 46 per cent., Kashmir 37 per cent., Punjab 28 per cent., Baluchistan 18 per cent., and Bengal 17 per cent.—are such as to call for serious attention.

## THE SYSTEM FOR STORM WARNING.

19. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director-General of Observatories, and from the Calcutta Office by the Meteorologist, Calcutta.

The following ports are warned from Simla for storms in the Arabian Sea :—

Aden, Karachi, Cutch Mandvi, Jamnagar, Dwarka, Porbandar, Veraval, Jafarabad, Bhavnagar, Daman, Bombay, Aliabagh, Murud Janjira, Harnai, Ratnagiri, Malvan, Vengurla, Nova Goa, Marmagao, Karwar, Kumta, Honavar, Mangalore, Tellicherry, Calicut, Cochin, Alleppy, Quilon, Trivandrum, Colachel, Busra, and Colombo.

The Meteorologist, Calcutta, warns the following ports for storms in the Bay of Bengal :—

Colombo, Tuticorin, Pamban, Negapatam, Porto Novo, Cuddalore, Madras, Masulipatam, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Puri, Hukitala (False Point), Chandbali, Sandheads, Saugor Island, Diamond Harbour, Mud Point, Budge Budge, Calcutta, Khulna, Barisal, Goalundo, Narayanganj, Chandpur, Noakhali, Chittagong, Cox's Bazar, Akyab, Kyaukpyu, Diamond Island, Bassein, Rangoon, Elephant Point, Moulmein, Tavoy, Mergui, Table Island (reopened on 15th August 1916), and Port Blair.

The following River Police stations in Eastern Bengal and Sunderbans are also warned :—

Nikli, Bhairab, Chandpur, Mirzaganj, Narayanganj, Madaripur, Gopalganj, Gournadi, Goalundo, Aralia, Sirajgang, Lohajang, Sara, Godagari, Rampur Boalia and Khoksa.

20. In addition to special messages sent during stormy weather the Meteorologist, Calcutta, provides shipping with daily information regarding the weather over the Bay. The following ports receive daily telegrams under the "General system with additional signals" :—

- |                     |                     |
|---------------------|---------------------|
| (1) Table Island.   | (8) Madras.         |
| (2) Elephant Point. | (9) Cuddalore.      |
| (3) Diamond Island. | (10) Porto Novo.    |
| (4) Akyab.          | (11) Bassein.       |
| (5) Chittagong.     | (12) Rangoon.       |
| (6) Negapatam.      | (13) Saugor Island. |
| (7) Cocanada.       | (14) Sandheads.     |

*Note.*—Ports (1) to (12) however receive no telegrams during the period 15th January to 31st March. On the 15th January a telegram is sent to these ports saying the Ball indicating fine weather should remain suspended until further orders. At the Sandheads signals are not exhibited, but information is available for passing vessels.

21. In accordance with resolutions passed at the International Radio-Telegraph Conference held in London in June and July 1912, the Indian Radio-Telegraph coast stations are now supplied with telegrams containing meteorological information with regard to the Arabian Sea and the Bay of Bengal. The messages are sent to the radio stations at Bombay, Karachi, Calcutta, Rangoon, Madras, and Port Blair for broadcast transmission by wireless to the shipping in the Arabian Sea and the Bay of Bengal.

Arrangements made for the receipt by wireless telegraphy of meteorological observations from ships at sea worked satisfactorily up to August 1914, when owing to the outbreak of the war these wireless telegrams had to be discontinued.

### WARNINGS FOR STORMS IN THE BAY OF BENGAL.

22. During the year warnings were issued for nineteen disturbances. Three of these developed into storms of some severity, and regarding the two most important a detailed statement is given here of their course and of the action taken.

#### *Storm of 30th April—3rd May 1917.*

A depression began to form in the south of the Bay on the 30th April. At 8 hrs. on the 1st May it was still without any definite centre; but was lying about 300 or 400 miles to the east of Negapatam. During the next 24 hours it developed into a storm, and moved in a northerly direction to a position about 400 miles east of Nellore. It then travelled with unusual rapidity and was about 75 miles east of False Point by 8 hours of the 3rd, crossing the coast the same afternoon between Balasore and Saugor Island.

The ports which were likely to be affected or from which vessels might run into the storm were informed daily from the 1st May of the progress of the storm, so far as was ascertained from the coast observations, and signals were hoisted. The action taken with regard to Saugor Island and Balasore is shown by the following telegrams :—

### *Saugor Island.*

1st May at 10 hrs. 45 mins. Hoist distant cautionary (a) section four.\* Weather suspicious off south Madras coast.

2nd May at 11 hrs. 8 mins. Hoist distant warning (b) sections four five.\* Storm position doubtful roughly four hundred miles east, Negapatam. Track uncertain.

3rd May at 8 hrs. 15 mins. Hoist distant warning (b) sections two three.\* Storm reached north Bay moving some northerly direction will wire later approximate position centre.

3rd May at 9 hrs. 17 mins. Hoist danger signal number seven (d).

3rd May at 20 hrs. Lower storm signal hoist ball (f). Storm now inland.

### *Balasore.*

3rd May at 9 hrs. 22 mins. Hoist great danger signal (e). Severe storm may strike you almost at once.

3rd May at 18 hrs. Lower storm signal. Storm crossing coast near Saugor Island.

As Balasore possessed only the brief system of signals it was not necessary to hoist any signal there until the port was threatened. The actual notice given was rather short as the position of the storm was not realised until the morning of the 3rd.

### *Storm of 24th—30th October 1917.*

A storm was forming near the Andamans on the 24th October. It developed and moved in a north-westerly direction until the morning of the 28th, when it was about 150 miles south-east of Gopalpur; it then took a northerly course and was close to the coast off Gopalpur on the morning of the 29th. After this it travelled along the coast and was to the north of Calcutta on the evening of the 30th.

The ports which were likely to be affected or from which vessels might run into the storm were informed daily from the 25th of the progress of the storm, and signals were hoisted. The action taken with regard to Hukitala, Diamond Harbour and Calcutta is shown by the following telegrams :—

### *Hukitala (False Point).*

25th October at 11 hrs. 22 mins. Hoist distant cautionary (a). Weather disturbed north-west Port Blair two hundred miles.

26th October at 10 hrs. 37 mins. Weather disturbed two hundred miles west-south-west Diamond Island.

27th October at 11 hrs. 8 mins. Weather disturbed centre Bay between Waltair and Diamond Island.

27th October at 21 hrs. 41 mins. Hoist local cautionary (c). Moderate storm two hundred miles off Calingupatam approaching coast.

28th October at 11 hrs. 35 mins. Moderate storm two hundred miles off coast latitude nineteen.

29th October at 11 hrs. 12 mins. Moderate storm on coast near Gopalpur. Weather squally Orissa coast and north-west angle Bay.

30th October at 13 hrs. 2 mins. Lower storm signal. Storm north-west Balasore moving north-east weather still squally north west angle Bay.

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\*Refers to the sections of the Bay which were affected.

(a) Indicating that there was a region of squally weather in which a storm might be forming.

(b) Indicating that a storm had formed.

(c) Indicating that the port was threatened by squally weather.

(d) Indicating that the port would experience severe weather from a storm of slight or moderate intensity that was expected to cross over or near to the port.

(e) Indicating that the port would experience severe weather from a storm of great intensity that was expected to cross over or near to the port.

(f) Indicating fine weather.

*Diamond Harbour.*

\*25th October at 11 hrs. 19 mins. Hoist distant cautionary (a). Weather disturbed north-west Port Blair two hundred miles.

26th October at 10 hrs. 46 mins. Weather disturbed two hundred miles west-south-west Diamond Island.

27th October at 11 hrs. 2 mins. Weather disturbed centre Bay between Waltair and Diamond Island.

\*27th October at 22 hrs. 14 mins. Hoist distant warning (b). Moderate storm two hundred miles off Calingapatam.

28th October at 11 hrs. 32 mins. Moderate storm two hundred miles off coast latitude nineteen.

29th October at 11 hrs. 15 mins. Moderate storm on coast near Gopalpur. Weather squally Orissa coast and north-west angle Bay.

\*29th October at 12 hrs. 40 mins. Hoist local cautionary (c).

30th October at 13 hrs. 5 mins. Storm fifty miles north-west Balasore moving north-east. Weather squally north-west angle Bay.

\*30th October at 21 hrs. 10 mins. Lower storm signal. Storm slightly north-west Calcutta moving east-north-easterly giving heavy rain.

*Calcutta.*

The telegrams sent to Calcutta were those shown under Diamond Harbour with an asterisk.

It appears that although the position of the storm was correctly indicated to the ports affected, the signals did not very adequately convey the degree of danger. At Hukitala for instance only 'cautionary' signals, indicating squally weather, were hoisted, but not 'danger' signals to indicate the admitted existence of a 'moderate storm.' At Calcutta and Diamond Harbour the local danger signals should have been hoisted. Fortunately however although winds at sea were fairly strong those on shore were quite feeble and probably no harm was done.

**STORM OF 29TH SEPTEMBER—2ND OCTOBER 1917.**

This storm was of slight intensity and affected a comparatively small area. The signals hoisted gave adequate warning to the ports concerned.

**WARNING FOR STORMS IN THE ARABIAN SEA DURING THE YEAR.**

23. The Simla Office warns the west coast ports, not only for storms, but also for squally weather, especially at the beginning of the monsoon. There were eleven periods of disturbed weather in the Arabian Sea for which warnings were issued, but only two of these disturbances developed into storms.

The first formed during the advance of the monsoon which occurred at the Malabar coast near the end of May. Signals were hoisted at the ports telling of the likelihood of squally weather on the 25th, and were lowered on the 26th as the disturbance receded from the coast. In the meantime a severe storm had formed, probably in the west of the Arabian Sea, which was encountered by the S.S. "Portsea" on the 25th-26th May in the neighbourhood of the Kuria Maria Island. No further signals were hoisted as the storm formed too far from our west coast stations to affect their observations.

**STORM OF 18TH—25TH OCTOBER 1917.**

A storm of moderate severity formed off Malabar on the 18th and 19th October and travelled in a northerly direction. It struck the Kathiawar coast near Porbandar at noon on the 25th.

The ports which were likely to be affected or from which ships might run into the storm were informed daily from the 18th of the development and movement of the storm, and the appropriate signals were hoisted. As the storm was

(a) Indicating that there was a region of squally weather in which a storm might be forming.

(b) Indicating that a storm had formed.

(c) Indicating that the port was threatened by squally weather.

during the greater part of its existence at a considerable distance from the coast the observations at the coast stations did not give any clear indication of either its position or character. The action taken is shown by the following telegrams sent to Veraval, Porbandar and Dwarka :—

18th October at 11 hrs. 52 mins. Disturbed conditions off Malabar coast. Hoist signal number one distant cautionary (a).

19th October at 12 hrs. 4 mins. Conditions are still disturbed south-east Arabian Sea.

20th October at 11 hrs. 53 mins. Storm probably forming fourteen degrees north sixty-eight east.

20th October at 22 hrs. 24 mins. Indications of disturbance fainter perhaps moving west.

21st October at 11 hrs. 55 mins. Disturbance apparently unchanged.

21st October at 22 hrs. 2 mins. Disturbance apparently unchanged.

22nd October at 11 hrs. 56 mins. Disturbance still appears about sixteen north sixty-eight east.

22nd October at 21 hrs. 56 mins. Depression probably giving disturbed weather south-east Arabian Sea.

23rd October at 12 hrs. 39 mins. Replace signal number one distant cautionary (a) by signal number three local cautionary (c). Storm probably forming seventeen north sixty-eight east may give rough weather your port.

23rd October at 18 hrs. 24 mins. Storm probably formed about eighteen north sixty-seven east. Replace signal number three local cautionary (c) by signal number four local warning (g).

23rd October at 23 hrs. Observations indicate very little change in storm.

24th October at 11 hrs. 55 mins. Replace signal number four warning (g) by number seven danger (d). Storm two hundred miles off Veraval threatens your port.

24th October at 16 hrs. 46 mins. Storm hundred fifty miles south-west of Veraval moving north or north-east.

24th October at 23 hrs. 7 mins. Storm now about hundred miles south-west of Veraval moving northwards perhaps weakening will probably cross coast near Porbandar noon tomorrow Thursday.

25th October at 5 hrs. 7 mins. Storm still moving very slowly northwards.

25th October at 11 hrs. 42 mins. Storm of moderate severity now crossing inland near Dwarka.

25th October at 16 hrs. 25 mins. Storm passed inland over Porbandar about noon strong winds will persist to-day.

25th October at 22 hrs. 20 mins. Storm slowly weakening inland but still causing rough weather.

26th October at 10 hrs. 51 mins. Storm now in Rajputana lower signal.

#### INFORMATION IN CONNECTION WITH THE SENDING OF VESSELS TO MESOPOTAMIA.

24. Information regarding weather in the Bay was sent by the Meteorologist, Calcutta, to the Captain Superintendent, Royal Indian Marine Dockyard, Calcutta, and the Principal Port Officer, Rangoon, in connection with the towage of vessels intended for Mesopotamia. Corresponding information regarding the Arabian Sea was sent by Simla to the Director of Indian Marine, Bombay, the Port Officer, Pamban, and the Naval Intelligence Officer, Colombo.

(a) Indicating that there was a region of equally weather in which a storm might be forming.

(c) Indicating that the port was threatened by equally weather.

(d) Indicating that the port would experience severe weather from a storm of slight or moderate intensity that was expected to cross over or near to the port.

(g) Indicating that the port was threatened by a storm but that it did not yet appear that the danger was sufficiently great to justify extreme measures of precaution.

## FLOOD WARNING AND WEATHER FORECASTS TO DISTRICT, IRRIGATION, RAILWAY AND OTHER OFFICERS.

25. This work is carried out chiefly by the Simla Meteorological Office, and partly by that of Calcutta. The arrangements have been made at various times and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In most cases these officers require telegrams either warning them of advancing storms likely to give heavy rain, or informing them of the actual occurrence of heavy rainfall likely to give rise to severe floods which might injure railways or canal works; and in other cases they require warnings or forecasts of the weather for as long a period beforehand as possible.

The number of district officers and officers in the irrigation, telegraph, railway and other departments requiring flood warnings from Simla amounted at the end of the year to 206, as compared with 201 in the previous year. There were also 5 officers of the Telegraph Department who required warnings for strong winds.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

The number of warning messages sent from Simla during the year 1917-18 was 5,789 as compared with 4,879 in 1916-17 and 2,838 in 1915-16. In addition to these there were 26 warnings for strong winds sent to officers of the Telegraph Department.

The number of warnings for heavy rainfall and strong winds sent from Calcutta during the year 1917-18 was 1,100 and for only strong winds 255, thus making a total of 1,355, as compared with 607 in 1916-17.

26. Instructions were issued by the Government of India in 1898 that every officer to whom storm or flood warnings are issued should in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the head of this department a brief return of the warnings received and should also report—

- (1) whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department;
- (2) whether the warnings were timely and satisfactory in every respect and, if not, in what points they were defective;
- (3) whether any changes might be made in the system which would make the warnings more useful.

Reports on the ordinary storm and flood warnings for the calendar year 1917 were received from 43 officers. Of these 34 stated that the warnings were satisfactory, but there were frequent delays in transmission in the case of warnings sent to Orissa, probably owing to interruptions on the line. One officer stated that the warnings arrive rather late and 8 offered no remarks.

A comparison of the reports of floods and of heavy rain with information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were of value to the recipients. As an illustration the following note may be of interest. It formed part of the report submitted by the Executive Engineer, Rupar Division, Sirhind Canal:—

“I may specially note that the storm telegram gave us timely warning of the approach of the abnormal and very heavy monsoon storm at the end of October, and the canal was consequently closed in good time in anticipation of nil indents, which was very beneficial for all concerned.”

### SEASONAL FORECASTS.

27. The forecast for the monsoon period of 1917, dated the 6th June, was sent to Local Governments and Administrations, communicated to the press, and printed in the Gazette. A statement of the rainfall of June and July with a forecast for

August and September was drawn up on the 7th August 1917 and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 1st January 1918 and sent to Local Governments and Administrations.

The following are summaries of these two forecasts and comparison of them with the actual rainfall :—

Forecast dated the 6th June 1917.	REMARKS.
<p>(a) The outlook for the general monsoon rainfall of India is on the whole favourable, and the rainfall is likely to be in excess, at any rate in the earlier part of the season.</p> <p>(b) In spite of the recent cold there is no reason to expect that the rainfall of north-west India will suffer to any marked extent by comparison with that of the rest of India.</p>	<p>The general monsoon rainfall was in excess by slightly over seven inches, or twenty per cent and the total for each half of the season was in excess.</p> <p>The percentage excesses of the provinces of north-west India were: United Provinces 22, Punjab 92, Kashmir 53, North-West Frontier Province 64, Sind 111, Rajputana 103, Central India West 35, and Gujarat 28. It will be seen therefore that the rainfall of north-west India was far from suffering by comparison with that of the rest of India.</p>
Forecast dated the 7th August 1917.	REMARKS.
<p>(a) The total rainfall of August and September is likely to be in excess.</p> <p>(b) The indications regarding the geographical distribution are not sufficiently strongly developed to be reliable. They merely suggest that the United Provinces West and neighbouring districts may fare better than the rest of India in the ratio of the actual to the normal rainfall.</p>	<p>The rainfall of the period was in excess by 5.7 inches or 31 per cent.</p> <p>The percentage excesses of the districts in question were:- United Provinces West 53, United Provinces East 17, Central India West 49, Rajputana East 138, Punjab East and North 139.</p>

Both in June and August the anticipations of a general excess of rainfall were justified.

Regarding the geographical distribution reasons were given in June for expecting that both the Arabian Sea and the Bay monsoon currents would be stronger than usual, as well as that there would be no prejudicial effect of snowfall in north-west India. These expectations were fulfilled.

In the forecast for August and September the uncertain indications that the area about the United Provinces West would get a larger percentage rainfall than the rest of India proved correct. The average of the percentage excesses of the five divisions given above is 73, while that of the whole of India was 34.

28. A forecast of the probable character of the rains during January and February 1918 was prepared on the 2nd January 1918 and issued in the same manner as the forecast of the previous June. On the 3rd July 1918 a comparison of the actual precipitation with the above forecast was issued. The summary of the forecast issued was :—

"It is probable that the total amount of rainfall in north-west India and of snowfall on the neighbouring hills in January and February will be normal or in moderate excess."

The total amounts both of rainfall and snowfall during January and February were however decidedly less than usual and that the forecast was definitely wrong

## DAILY TELEGRAPHIC WEATHER SUMMARY.

29. The summary was despatched daily at about noon. It was exhibited at certain telegraph offices and sent to 82 officers of Government. The subscribers for longer or shorter periods were 10 newspapers and 42 private individuals. To officers in Simla sheets containing the summary with a chart showing the rainfall of the day are distributed by hand.

## PUBLICATIONS.

30. There were no changes made during the year in the form of the routine publications of the department of which a description will be found in the departmental administration reports of 1907-08 and 1910-11 : but in view of the shortage of paper the publication of the Monthly Weather Review had been stopped after the number for October 1916 and the publication of the Annual Summary after that for 1915. The monthly and annual supplements to the Indian Daily Weather Report have been printed as usual, and supply the general need for prompt information.

## SUPPLY OF METEOROLOGICAL INFORMATION.

31. In addition to the meteorological information published by the department special information was supplied to the Meteorological Departments of England, Australia and Egypt.

Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as for private firms who are willing to pay the expense necessarily incurred. The extent to which the department is utilised in this manner will be seen from the chart appended.

## MISCELLANEOUS.

32. Four hundred and eleven books and pamphlets, either purchased or presented by scientific bodies, were added to the library during the year, as against three hundred and thirty-two in the year 1916-17.

Eight libraries, observatories or societies were added during the year to the list of institutions to which the publications of the Indian Meteorological Department are supplied, and one was removed ; the number on the list is now 370.

## CHIEF FEATURES OF THE YEAR.

33. At the beginning of the year Dr. Simpson, Imperial Meteorologist, left the Simla office to become Assistant Secretary to the Board of Munitions during the war ; and as the Simla office had already lost the services of Mr. Normand, who had been appointed meteorologist with the forces in Mesopotamia, its scientific activities were in a very depressed state.

Use was however made of the computing staff to compute, statistical methods, a number of correlation coefficients bearing on the distribution of monsoon rainfall, as well as others dealing with sanitary and economical questions.

At the Solar Physics Observatory, Kodaikanal, also the staff was materially reduced ; Dr. Royds, the Assistant Director, joined the Indian Army Reserve of Officers in October 1917 for ordnance work.

During the year the department has lost the services of Mr. C. W. Peake, Professor in Physics at the Presidency College, Calcutta. He had served as Meteorologist, Calcutta, with much zeal and efficiency since 1906.

The routine work of the department was maintained with but little change except that the publication of the Indian Monthly Weather Review and its Annual Summary was discontinued in view of printing difficulties during the war ; it was considered that the monthly and annual supplements to the Indian Daily Weather Report, which were being maintained, were sufficient for most administrative purposes. Among the weather observing stations the chief event has been the closing of those at Sarain and Kalabagh on the Chur Peak. These had been started by Sir John Eliot as upper air observatories. But general experience has shown that measurements made on mountains differ appreciably



from those in the free air ; also the inaccessibility of the Chur Peak made effective supervision extremely difficult ; hence it became clear that the results were not worth their cost.

There were during the year three storms of importance in the Bay and two in the Arabian Sea : warnings were given to the Indian ports for all except one which was too near Arabia to affect the observatories on our west coast.

#### CONCLUDING REMARKS.

34. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of Government departments, as unpaid superintendents of observatories and in other capacities, help in the meteorological work ; the Telegraph and Postal Departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employees to act as observers. The Indo-European Telegraph Department, also, by giving free transit to the daily records of the Persian observatories, places a large amount of most useful information at the disposal of the Meteorological Department. Weekly telegrams were received from May to September from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the Indian Meteorological Department.

The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the south-west monsoon to the Director, Physical Service, Survey Department, Cairo ; the Directors of the Observatories at Buenos Ayres and Santiago : and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

SIMLA :

GILBERT T. WALKER,

*The 27th September 1918.*

*Director General of Observatories.*

# GROWTH IN DEPARTMENTAL ACTIVITY AND CHANGES IN TOTAL COST

